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REMARKS

Rejection of Claims 21-40 Under 35 U.S.C. §103(a), based on Advanced PVD Ti/TiN Liners for Contact and Via Applications, SPI Vol. 3214 (1997) (Barth et al.).

5 The rejection of claims 21-31 will first be addressed.

Claim 21 is directed to a method forming a contact plug that includes selectively making a hole in an insulating layer, forming a barrier layer on the insulating layer and a hole side-wall surface, and depositing a conductive layer over the barrier layer while filling a hole space. The method also includes etching back the conductive layer to expose a barrier layer and form a plug
10 portion with a top surface that projects above a top surface of the insulating layer. Further, the method includes removing a first portion of the barrier layer until the top surface of the insulating layer is exposed and a contact plug top surface projects above a top surface of the insulating layer.

As is well understood, to establish a prima facie case of obviousness, a rejection must
15 meet three basic criteria. First, there must be some suggestion or motivation to modify a reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference(s) must teach or suggest all claim limitations.

It is admitted that the reference relied upon, *Barth et al.*, does not show etching back a conductive layer to form a plug that has a top surface which projects above a top surface of an
20 insulating layer.¹

To show such a limitation, the rejection takes official notice that such a process is conventional or at least well known in the semiconductor processing arts. Applicant seasonably traverses this statement and respectfully requests evidence in support. It is not believed that such a limitation, when included with the other limitations of claim 21, is either obvious or well
25 known.

Further, the rejection shows such a limitation is obvious as it involves alternate and at least equivalent means.

In order to rely on equivalence as a rationale supporting an obviousness rejection, the equivalency must be recognized in the prior art, and cannot be based on applicant's disclosure, or

¹ See the Office Action, dated 7/31/02, Page 5, Lines 8-9.

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the mere fact that the components at issue are functional or mechanical equivalents.² It is noted that Applicant uses, asymmetrical deposition (to form a barrier layer that is greater in thickness on a top surface than a side surface) in combination with the etching back of a conductive layer to form a plug, in order to form a plug which projects above a top surface.

5 The only reference relied upon, *Barth et al.*, provides only a brief mention of an etch back description that with no description of a resulting plug shape, and so is not believed to be suggestive of Applicant's invention.³ Thus, the prior art presented does not appear recognize any equivalent etchback to the arrangement as claimed.

10 For these reasons, it is not believed that a prima facie case of obviousness has been established for claims 21-31. Accordingly, this ground for rejection is traversed.

The rejection of claims 32-35 will now be addressed.

15 The invention of claim 32 is directed to a method of forming a contact hole that includes the steps of etching through a first insulating film to form a contact hole, depositing a first conductive film on the first insulating layer and a contact hole side inner surface, depositing a second conductive film on the first conductive film, depositing a third conductive film that fills the contact hole. The method further includes etching to expose the first insulating film around the contact hole and form a plug from the third conductive film. The plug extends above the top surface of the first insulating film.

20 As noted above, it is admitted that *Barth et al.* does not show an etching back to form a plug that has a top surface which projects above a top surface of an insulating layer, as claimed. Accordingly, Applicant incorporates by reference herein the comments set forth above for claim 1. Namely, that the rationale relied upon is not sufficient absent the presentation of evidence in support.

25 Claim 35, which depends from claim 32, adds the very particular limitation of etching the third conductive film to a level below the first conductive film and above the first insulating film. In addition, the first and second conductive films are etched to expose the top surface of the first insulating film.

² See MPEP §2144.06.

³ See *Barth et al.*, Page 6, Last Paragraph, which only describes "a standard W-plug fill (W-CVD + etchback). There is no description of a top surface of such a plug extending above a top surface of an insulating layer.

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Applicants incorporate by reference herein the comments for claim 1. Namely, that rejection is not sufficient absent the submission of additional evidence in support.

The rejection of claims 36-40 will now be addressed.

5 Claim 36 is directed to a method that includes depositing a first conductive film over a first insulating layer having a hole formed therein, the first conductive film being thicker over a top surface of the first insulating layer than on a side surface of the hole. The method also includes depositing a second conductive film over the first conductive film, and a third conductive film over the second conductive film and within the hole.

10 The method further includes etching a third conductive film selective to the second conductive film to expose the second conductive film around the hole with the third conductive film is only within the hole and has a plug top that extends above the top surface of the first insulating layer but below a top surface of the second conductive film.

To address this ground for rejection, Applicant incorporates by reference the comments
15 set forth for claim 1.

New Claims 41-48.

New claim 41 recites a method of forming a contact plug that includes forming a barrier layer on the surface of an insulating layer, where such barrier layer includes a first portion on a
20 top surface of the insulating layer and a second portion on a side-wall surface that defines a hole. The barrier layer comprises a titanium film. Such a titanium film has a first part in a first portion of a barrier layer. The thickness of the first part of the titanium film is 100 nm or more.

The method also includes depositing a conductive layer over the barrier layer that fills a space corresponding to the hole. The conductive layer is then etched back to form a plug with a
25 top surface which projects above the top surface of the insulating layer.

The reference *Barth et al.*, while mentioning a Ti/TiN barrier and W layer etchback, fails to show or suggest how a W layer, as well as a barrier layer, are etched back. Thus, the reference is not believed to show or suggest Applicant's new claim 41, which recites etching to form a very particular plug configuration.

30 *Barth et al.* also fails to show titanium film of a barrier layer having a thickness of 100 nm or more. As shown by Applicant's specification, such a titanium film thickness may enable

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an upward projecting plug shape that may address disadvantages inherent in conventional approaches.⁴ *Barth et al.*, as noted above, provides no teachings regarding resulting plug shape, and so cannot address the problem solved by Applicant's method.

It is recognized that *Barth et al.* does include a table illustrating basic film properties of a titanium layer having a thickness of 100 nm.⁵ However, this table is provided to show film properties and deposition parameters. When *Barth et al.* describes actual contact barrier layers, a resulting thickness of such titanium film is shown to be 10 nm, 20nm, or 40 nm.⁶ Thus, the barrier layer teachings of *Barth et al.* appear to teach away from Applicant's 100 nm (or greater) limitation. Further, due to a reduced thickness of a titanium layer in *Barth et al.*, a resulting etchback process would appear no different than the conventional case shown in Applicant's 3A-3D, which can result in an indented W plug shape, rather than one that projects upward, as claimed.

Accordingly, new claims 41-48 are believed to be patentable over the cited art.

The present claims 21-48 are believed to be in allowable form. It is respectfully requested that the application be forwarded for allowance and issue.

Respectfully Submitted,

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⁴ See the Specification, Page 7, Line 11 to Page 8, Line 14.

⁵ See *Barth et al.*, Page 5, Table 1.

⁶ See *Barth et al.*, Page 6, last paragraph, which shows Ti/TiN barrier layer examples of 10/20 nm, 20/40 nm, 20/80 nm, and 40/100 nm.